Fieldwork ideas: The water cycle

This resource is part of the toolkit that supports our AS and A-level Geography specifications (7036, 7037).

Hydrological investigations

Investigating the hydrological or water cycle at the local scale can involve carrying out data collection using simple apparatus to see how hydrological relationships vary.

Link with the specification

"Flows and transfers at hill slope and drainage basin scales

Drainage basins as open systems – inputs and outputs, to include precipitation, evapo-transpiration and runoff; stores and flows, to include: interception, surface, soil water, groundwater and channel storage; stemflow, infiltration overland flow and channel flow. Concept of water balance.

Runoff variation and the flood hydrograph."

Investigation ideas

- How do infiltration rate and infiltration capacity vary with slope, steepness, soil texture, geology and/or land use?
- Do infiltration rate and capacity decrease down a slope?
- How do rainfall and evaporation affect the level of water and speed and discharge of a river?
- How do different sections of a river respond to a period of rain?
- How does the passage of a storm affect interception, infiltration rates or stream characteristics such as discharge and velocity?
- How does the amount of interception vary with vegetation type and rainfall intensity?
- How is evaporation affected by wind speed, temperature, hours of sunshine, humidity and/or aspect?
- How do urban and grassy surfaces differ in their response to floods/rainfall?

Possible hypotheses

- Steep slopes have a higher infiltration capacity than gentle slopes.
- A change in weather conditions influences infiltration rates at the same site.
- Infiltration rates vary with vegetation type.
- Infiltration rates are affected by geology, soil type, slope angle and slope position.
- Different sections of a river respond to rainfall at different rates.

Possible methods

- Measure rainfall at set times (hourly, daily).
- Measure interception, by placing rain gauges in different places (under trees, in open ground etc).
- Measure evaporation using a plastic bucket containing water. Measure the depth at different times.
- Measure infiltration, using a tube or infiltration ring. Fill with water and record the drop in water levels every minute.

- Take soil samples to test for texture and moisture levels.
- Measure river flow variables-width, depth, velocity, discharge.

Sample investigation: factors affecting infiltration rates

Hypothesis: Infiltration rates are affected by soil type, slope angle and slope position.

Infiltration can be affected by a number of factors, including preceding weather conditions, slope angle, slope position, geology, soil texture, vegetation type and land use.

Data collection

Equipment

- Small tubes made of plastic piping or cans with bottoms removed
- Ruler, 20 metre tape
- Stop watch
- Trowel and mallet
- Plastic bags for each site
- Clinometer
- (set of soil sieves)

Methods

Choose a slope which leads down to a river. Try to select a slope with uniform geology and vegetation unless testing the impact of these factors. Select three to five transects with ten equidistant sites on each. Include the base and summit of the slopes.

At each site:

- measure angle of slope using a clinometer
- take a sample of topsoil to test soil texture and moisture levels. Place in a polythene bag with a sealed top
- use a trowel to cut a circle in the ground, and insert a home-made infiltration ring or infiltrometer eg a tube of plastic piping. Hammer in to a depth of 10 cm. Ensure the tube is vertical. Try to disturb the soil and vegetation as little as possible
- pour in water with a jug up to the top of the tube and record how many mms the water has fallen after one minute. Fill up the tube and record the drop in the second minute etc. Record infiltration rates for at least 10 minutes

- record the position on the slope, mark on a map and record site details (vegetation type, land use, slope variation etc). Identify any site factors that may lead to anomalies.

Encouraging independence during the planning and data collection phase

It is important to allow candidates to have the opportunity to demonstrate their independence in the following areas:

- planning the enquiry/posing enquiry questions and devising hypotheses Text
- selecting and implementing data collection techniques.

Processing data

When all the recordings have been taken, calculate:

- total fall over 10 minutes
- mean fall (mm per minute). This is the infiltration rate
- infiltration capacity. When the fall has become constant the infiltration capacity has been reached
- put the soil sample through sieves and test for percentage sand, silt and clay. Sand consists of particles of over 0.2 mm.

Presentation of results and statistical analysis

- Prepare a graph for each transect. Plot the fall in mm against time. Use a different colour or symbol for each site.
- Draw slope profiles for each transect. Underneath, draw located bars to show the infiltration rate and infiltration capacity.
- Draw scatter graphs or statistical correlation technique (Spearman's rank) to show the link between factors such as slope angle and infiltration rates, infiltration rates and infiltration capacity, position upslope and infiltration rates/capacity, infiltration rates and percentage sand.
- If the experiment has been carried out twice (eg, once in dry conditions and the second time after rainfall), use the chi –square test. Set a null hypothesis: "There is no difference between infiltration rates after wet and dry weather". The Mann-Whitney test is also suitable as a test of difference between two sets of data.

Analysis

The graphs and statistical tests will help in either supporting or rejecting the hypothesis. Evidence may be inconclusive. There may be a positive correlation between slope angle and infiltration capacity. If there is little correlation between

these variables, consider the extent to which slope position (or distance upslope) is more important than slope angle. How does soil texture affect infiltration rates/capacity? Is the finer material more concentrated at the base of the slope, leading to lower infiltration capacities?

Possible limitations

There is much scope for experimental error with the use of infiltrometers. It is difficult to keep a constant water supply, and sideways seepage at the bottom of the ring is often an issue. Faulty experimental technique may lead to a rejection of the hypothesis. Rates of infiltration are affected by many factors. It is difficult to isolate a few, and assume that other variables are not affecting results.

Extending the study

- Before inserting the infiltration ring, undertake a soil moisture test at each site. Is there a correlation between percentage moisture and infiltration rates or capacity?
- Compare infiltration rates under different types of vegetation along the transect routes.
- Compare infiltration rates under different weather conditions. Remember however that very dry antecedent weather conditions can lead to low infiltration rates as the ground may be hard and compact.
- Record how different soil conditions affect infiltration. For example, compare compacted soils where there has been heavy footpath use or cattle trampling with unaffected soils.
- Compare infiltration rates under different geological conditions.

Sources of secondary data

- There are several useful sources of hydrological data for the UK. The National River Flow Archive (river level data) and the Environment Agency (river and sea level data) websites may be useful.
- It is also useful to obtain weather data for the weeks before starting the fieldwork. The Met Office archive is an excellent place to start. It provides monthly summaries back to 1998, with links to older station data as well.
- For more information about the rocks and other sediments in the drainage basin, the British Geological Survey's site Geology of Britain is a useful geographical information system.